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Research Program for Effects of Acidic
Deposition on Materials and Cultural Resources

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16. ABSTRACT Task Group G, Effects on Materials and Cultural Resources, is part of the Inter-agency Task Force on Acid Precipitation that was established by the Acid Precipitation Act of 1980. There are currently eleven agencies participating in the Materials Effects Task Group. The National Park Service, U.S. Geological Survey, and the Environmental Protection Agency are the only participating agencies that receive funding from the Task Force. In planning the Materials Effects Research Program the Task Group has two basic objectives: (1) To develop the methodology and data bases for assessing material related benefits of acidic deposition control policies, and (2) To provide guidelines for protection or restoring individual structures especially historical and cultural sites. The first of these objectives is identified primarily with the regulatory responsibilities of the Environmental Protection Agency, while the second objective concerns the responsibilities within the National Park Service. To address these objectives the Task Group has adopted seven areas of research: (1) Atmospheric Measurement Technology, (2) Damage Measurement, (3) Materials Deterioration Rates, (4) Materials Inventory, (5) Cost Data Collection, (6) Model Development and Assessment, and (7) Protection and Mitigation Strategies. The presentation will include a discussion of the on-going research in these areas.		
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RESEARCH PROGRAM FOR EFFECTS ON MATERIALS AND CULTURAL RESOURCES, J.W. Spence
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Introduction

Task Group G, Effects on Materials and Cultural Resources, is one of ten task groups within the Interagency Task Force on Acid Precipitation. The Task Force was established by the Acid Precipitation Act of 1980 (Title VII of the Energy Security Act of 1980-P.L.96-294). The main responsibilities of the Task Force are:

- (1) To develop a National Acid Precipitation Assessment Plan;
- (2) To implement and oversee a 10-year comprehensive research program; and
- (3) To provide Annual Reports on program progress.

The purpose of the National Acid Precipitation Assessment Program is to provide a scientific data base on the causes and effects of acid precipitation. The Interagency Task Force is jointly chaired by the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, and the Department of Agriculture. The leaders of the task groups and the chairman of the National Laboratory Consortium form a Research Coordination Council which is chaired by the program's Executive Director, Dr. Chris Bernabo. The Research Coordination Council provides a forum that develops plans, budgets, reports, etc. for the Interagency Task Force.^{1,2}

Task Group G: Effects on Materials and Cultural Resources

Dr. Raymond Herrmann, Department of Interior, Water Resources Division, is the leader of Task Force G, Effects on Materials and Cultural Resources. Main participants on the Task Group G are as follows:

Argonne National Laboratory,
Brookhaven National Laboratory,
Bureau of Mines,
Corp of Engineers,
Environmental Protection Agency,
General Services Administration,
National Bureau of Standards,
National Park Service,
National Science Foundation,
Tennessee Valley Authority, and
U.S. Geological Survey.

The Environmental Protection Agency, National Park Service, and U.S. Geological Survey are the only participants of Task Group G that receive funding. The Bureau of Mines, National Bureau of Standards, Argonne National Laboratory and Brookhaven National Laboratory participate in the research program. The remaining participants serve the Task Group as consultants or advisors.

The Task Group has two overall objectives or goals in developing a research program on the effects of acidic wet and dry deposition on materials:

- (1) Data bases and methods for assessing the materials-related benefits of acidic deposition control policies.
- (2) Guidelines for protecting individual structures from the effects of acidic deposition or restoring damaged structures.

The first goal is identified primarily with the regulatory responsibilities of the Environmental Protection Agency, whereas the second goal concerns responsibilities within the National Park Service. More than 10,000 historic structures of significant cultural art and architecture design are overseen by the National Park Services. Protection of historic structures through effective damage prevention or mitigation methods is also of interest to the General Services Administration, as well as state and local governments.²

Material Effects Research Program

Man-made and naturally occurring materials are used extensively in structures such as buildings, monuments, electrical transmission towers, and highway bridges, and are exposed to acidic deposition. These materials include galvanized steel, bronze alloys, weathering steel, marble, paints, limestone, cement and are of concern in this research program.

Previous field and laboratory exposure studies have shown that air pollutants, especially SO₂, have detrimental effects on some of these materials. A review of these previous investigations can be found in the US-Canadian Transboundary Document³ and the Critical Assessment Document.⁴ These studies will provide guidance to the Task Group in developing a research program for studying the effects of acidic deposition on structural materials and cultural resources.

The Task Group must design and conduct a comprehensive Materials Effects Research Program that will differentiate between normal expected weathering and the accelerated deterioration attributed to both dry and wet acidic deposition. The program must produce scientific information as input for Assessment and Policy Analysis which is the responsibility of Task Group I of the Interagency Task Force. Task Group G has identified seven areas of research that will constitute the Materials Effects Research Program. A brief description of the research needed within each area of the program is as follows:

Atmospheric Measurement Technology. Simple inexpensive devices are needed for monitoring acidic deposition at historic sites and at field exposure sites of materials.

Materials Damage Measurement Technology. In situ, non-destructive methods are required for assessing acidic deposition damage to historic materials such as masonry, bronze, and coatings.

Materials Deterioration Rates. Field, laboratory, and retrospective studies need to be conducted to provide damage functions that relate materials damage to ambient environmental variables (humidity, pollutant, wet and dry acidic deposition, etc.).

Materials Inventory. Materials-at-risk need to be identified and the distribution of these materials across the US, particularly within the north-eastern US, need to be estimated.

Cost Data Collection. Replacement and maintenance-frequency factors (life cycle cost) and the value of nonreplaceable cultural properties are required in order to develop benefit models.

Model Development and Assessment. Economic models for estimating the effects of acidic deposition damage to materials and historical sites needs to be developed and will be a major product of the research program.

Protection and Mitigation. Techniques for protecting structures particularly our cultural resources, need to be developed and are an essential aspect of this research program.

The research areas of the Materials Effects Research Program are interconnected as shown in Figure I.

As observed, the focus of the Materials Effects Research Program is in the development of economic models and remedial action options. The economic models will be developed from primarily three research areas: Material Inventory, Cost Data Collection, and Materials Damage Rates. The models will provide two major research outputs:

- (1) An economic analysis or assessment of acidic deposition damage to materials and cultural resources.
- (2) Direct effects of acidic deposition on various materials.

The remedial action options will be formulated into a remedial action plan that will prescribe appropriate protective measures to protect our cultural resources. The plan will be developed from projects involving the structural monitoring of historic sites. Projects within three other research areas: Materials Damage Rates, Atmospheric Measurement Techniques, and Damage Measurement Techniques will also provide input to the development of the Remedial Action Plan.

Funding Level for Materials Program

The funds allocated in FY82, 83, and 84 for the Materials Effects Research Program are shown in Table I for each research area.

MAJOR RESEARCH OUTPUTS

RESEARCH AREAS

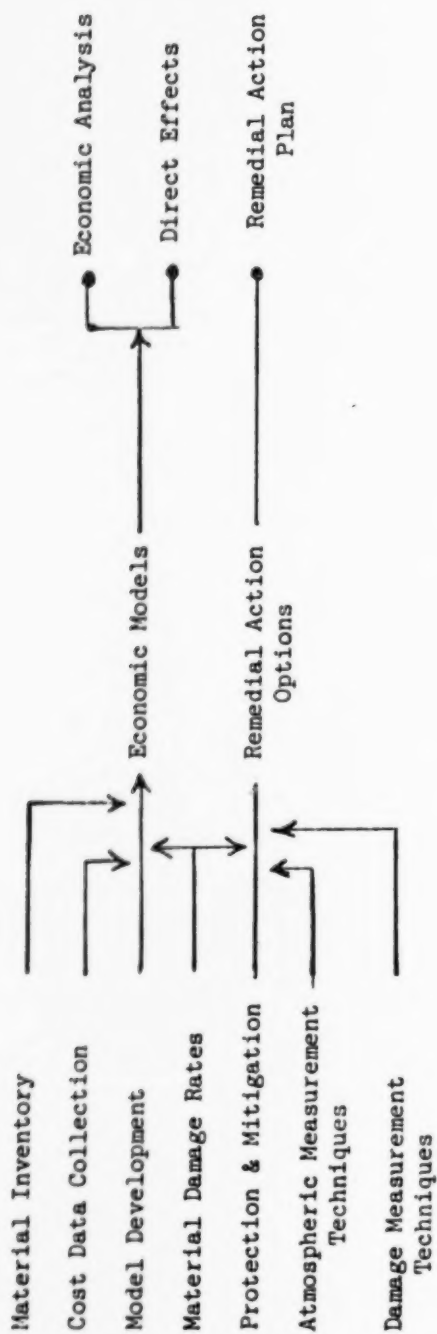


Figure 1. Relationships among the research areas of the Materials Effects Research Program

Table I. Funding for Materials Effects Research Program

Research Areas	Funding Level \$K		
	FY82	FY83	FY84
1. Atmospheric Measurement Techniques	37	0	0
2. Damage Measurement Techniques	75	200	210
3. Materials Deterioration Rates	140	355	590
4. Materials Inventory	90	60	300
5. Cost Data Collection	0	100	195
6. Model Development and Assessment	40	100	140
7. Protection and Mitigation	0	50	60
Total Budget	382	865	1,495

The Materials Program began its research effort in FY82. Unfortunately, the Materials Program didn't have an existing research program to build upon as was the case for other Task Groups involved in effects research. The Environmental Protection Agency is the only participating agency that maintains a program to study air pollutant effects on materials. Even this program has received limited funding over the past several years. Task Group G is, therefore, in the earlier stages of building and developing a Materials Effects Research Program.

Major funds are currently being directed to two areas of the Research Program: Materials Deterioration Rates and Materials Inventory. The materials deterioration rates have three components: Retrospective Analysis, Laboratory Exposures, and Field Exposures. The objectives of this research area are to refine existing damage functions for materials through laboratory exposure studies and retrospective analysis of existing materials damage data, and to develop damage functions for acidic deposition to materials through long-term field exposure studies. Exposure of materials is currently underway at four field sites - Research Triangle Institute, RTP, NC; Washington, D.C.; Chester, N.J.; and Huntington, N.Y. Air quality, meteorological, and precipitation chemistry are being recorded at each site. Additional exposure sites are planned but selection of the site location will depend on results from the laboratory simulation studies and retrospective analyses.

Projects within the Materials Inventory research area are planned to determine the geographic distribution of materials of construction and cultural resources. Cultural materials will be determined from primarily two sources: Federal Property Inventories and the National Registrar of Historic Places.

Estimation of the materials of construction will involve site surveys and data taken from population census, aerial photography, land use classification, etc. In FY84, the Task Group plans to make use of the land use data on file at the U.S. Geological Survey to estimate the materials of construction in the northeastern U.S. A project initiated in FY83 is conducting ground surveys of construction materials with three U.S. sites of different climatic conditions. Information from this study will provide input to the U.S. Geological Survey project. The estimate of the distribution of materials and cultural resources and the material damage functions for acidic deposition are vital components in the development of economic benefit models.

The Task Group also plans to initiate projects involving the monitoring of specific cultural properties. A prototype study is planned for monitoring the prehistoric structures at Mesa Verde National Park, Colorado. The specific objective is to characterize deterioration as a function of pollutant level, pH, and micrometeorological parameters. Data from these studies and from planned laboratory and field exposures of cultural materials will provide input for developing Remedial Action.

Major Deliverables

The Materials Effects Research Program will provide the Interagency Task Force with scientific information to perform an integrated assessment for policy option decisions. Major deliverables from the Research Program in 1987-90 are as follows:

- Provide damage functions that relate the effects of acidic deposition on materials. (These functions will be derived from field exposure data and will be expressed in terms of ambient environmental conditions.)
- Determine the nationwide distribution and quantities of materials and cultural resources exposed to acidic deposition.
- Provide a protection strategy for cultural resources.

As a current goal, the Interagency Task Force must produce an Assessment Report in 1985. The Materials Effects Research Program will provide for this report the following scientific information:

- An estimate of the distribution and quantities of materials-at-risk and cultural resources within the northeastern U.S.
- A refinement of existing damage functions through the use of laboratory techniques and retrospective analysis of existing materials damage data.

Although field exposure studies of materials are currently underway, damage functions will not be developed from these projects until 1987-90.

References

1. "National Acid Precipitation Assessment Plan," prepared by The Inter-agency Task Force on Acid Deposition, June 1982.
2. "Operating Research Plan for National Acid Precipitation Assessment Program," prepared by The Interagency Task Force on Acid Precipitation (First Draft) August 28, 1982.
3. "Effect on Man-Made Structures," United States-Canada: Memorandum of Intent on Transboundary Air Pollution, Phase III, to be published.
4. "Materials," Critical Assessment Document, to be published.